

Mansoura University	Faculty of Engineering	Electronics and Comm. Dept.	4 th Year, Optical Communication Systems	16/12/2015	Updated Sheet #4
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Q₁) Complete the following sentences with suitable word(s):

- In dense wavelength division multiplexing, the separation between successive wavelength is equal to
- Double hetero structure is defined as.....
- The Thickness of active material in double heterostructure should be less than.....
- The deBroglie wavelength at $T=300\text{K}$ for GaAs with $m^*=0.067m_0$ is equal to.....
- At thermal equilibrium, the probability of emission is..... than the probability of absorption .
- The energy of phonons lies within the range
- The momentum of electron isthat of phonon.
- The momentum of electron isthat of photon.
- The phonon hasenergy and momentum.
- The photon hasenergy and momentum.
- Absorption of energy with generates phonons.
- Absorption of energy (Eg-10mev) generates..... .

Q₂) Compare between:

- Photon and Phonon.
- Optical Phonon and acoustic Phonon.
- Radiative transition Non-Radiative transition.
- Photon assisted transition and phonon assisted transition.
- Structure $\text{Al}_{0.1}\text{Ga}_{0.9}\text{As}/\text{GaAs}/\text{Al}_{0.1}\text{Ga}_{0.9}\text{As}$, thickness of GaAs=15 nm and $\text{Al}_{0.1}\text{Ga}_{0.9}\text{As}/\text{GaAs}/\text{Al}_{0.1}\text{Ga}_{0.9}\text{As}$, thickness of GaAs=12 nm.
- The spontaneous emission, stimulated emission, absorption with the aid of(E-K)diagram & applications.
- Irradiance, Energy density and Flux
- Amplifier and attenuation using E-K diagram at $T=0\text{K}$.
- Interband transition & Intraband transition.
- Amplification gain coefficient at $T=0\text{K}$ and $T=300\text{K}$.
- Quantum efficiency and responsivity
- Carrier transit time and carrier recombination time
- Sensitivity, dynamic range and linearity of the detector

Q₃-Draw the following curves:

- Rate of spontaneous emission for $\text{Ga}_{0.9}\text{Al}_{0.1}\text{As}$ & $\text{Al}_{0.2}\text{Ga}_{0.9}\text{As}$ at $T=300\text{K}$
- Rate of spontaneous emission for $\text{Ga}_{0.9}\text{Al}_{0.1}\text{As}$ at $T=300\text{K}$ & $T=200\text{K}$ & $T=400\text{K}$
- Typical attenuation curves for Si, Ge, GaAs, GaN
- Responsivity vs. wavelength for Si and In Ga As

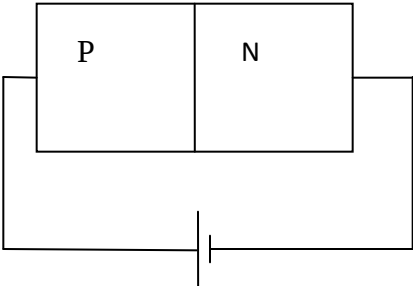
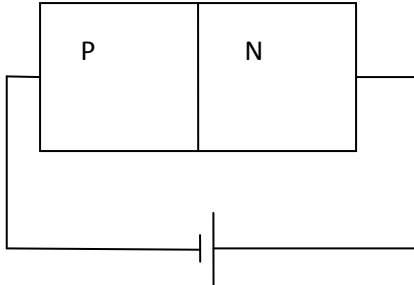
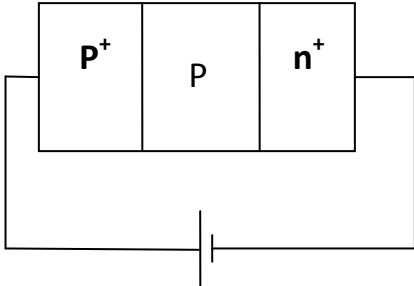
Q4) Given $\text{Al}_{0.2}\text{Ga}_{0.8}\text{As}/\text{GaAs}/\text{Al}_{0.2}\text{Ga}_{0.8}\text{As}$

- Draw the structure, defining (determine) the available thickness for GaAs layer
- Draw the band diagram for the structure qualitatively.
- Explain the operation of the structure with the aid of (b) and determine the application that this device can be used for.
- Determine the maximum and minimum emitted wavelengths.

Q5) Estimate the following relation

- Optical Joint of state $\rho_{c,v}(v)$.
- Rate of spontaneous emission.
- The probability of emission and absorption at thermal equilibrium.
- The probabilities of emission and absorption at quasi thermal equilibrium.
- K-selection rule.
- Amplification gain in stimulated emission
- Conditions for amplification (stimulated emission)

Q6) Given

P layer and N layer are made of Ga As 	P layer and N layer are made of Si 
$\text{P}^+ : \text{Al}_{0.1}\text{Ga}_{0.9}\text{As}$, $\text{P} : \text{GaAs}$, $\text{n}^+ : \text{Al}_{0.1}\text{Ga}_{0.9}\text{As}$ 	

- Draw the band diagram for each structure
- Explain the operation and define the function of each device.

c) Draw the variations of the spectra (spontaneous emission, attenuation constant and amplification gain) of each device vs.

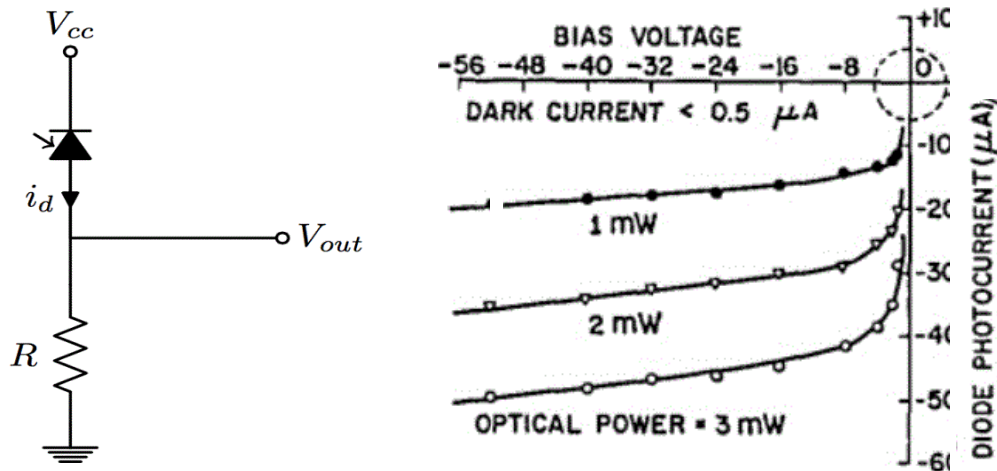
- ν (Frequency)
- λ (wavelength)

Q₇ Given semiconductor amplifier $\text{In}_{1-x}\text{Ga}_x\text{As}_{1-y}\text{P}_y$ with $E_g=1.12\text{ eV}$ & peak gain coefficient $=60\text{ cm}^{-1}$ and B.W $=300\text{ nm}$, draw the variation of gain coefficient vs. ν (Frequency) and λ (wavelength)

Q₈. Give reason for

- Si absorbs photon with energy $<1.1\text{ eV}$
- The width of P-layer in PN junction detector is less than N-layer
- InGaAs is preferred for designing fast response detector
- Ge is not preferred for designing sensitive detector
- Si is preferred for designing solar cells
- Quantum well structures are suitable for DWDM
- Coating the top of sensor by thin transparent conductive layer
- Sensor made from Ge is thinner than that made of Si with identical quantum efficiencies
- Purified materials are necessary for designing sensor with good responsivity
- Si is used sensor within the wavelength range 300 nm up to 1100 nm only

Q₉. Given the circuit below, with $V_{cc} = 24\text{ volt}$, $R = 12\text{ M}\Omega$



- Draw the load line of the circuit, the output voltage vs. the incident power
- Calculate the dynamic range and how to increase the dynamic range
- Calculate the sensitivity and how to increase the sensitivity
- Calculate the output noise power and how to decrease it.

Q₁₀. Explain the function, advantage of the PIN diode and give practical design.